ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *June* 10, 1831. No. 6.

THE following communications were read:—

I. Observed occultation of Jupiter and his satellites by the moon, June 1, 1831.

1. By the Astronomer Royal, giving the contact, immersion of Jupiter's centre, and total immersion, by four observers; and the emersions of Jupiter and the four satellites, by seven observers.

2. By Mr. Snow, containing the complete observations of all the immersions and emersions, made in Savile Row, together with the observed transits by which the clock error was determined.

Mr. Snow observes:

"Between the contact of the moon's limb with the planet, and the planet's disappearance, 1′ 32″ elapsed; and during that time no change of light, colour, or motion, took place in the planet, which remained uniformly of a rather more dusky colour than the moon. Both the planet and moon were in a violent state of undulation during the immersion; but the moon's undulation was seen quite distinctly upon the planet's disc, and differed, for that small arc, in no respect from the undulation of the rest of the limb. I watched very particularly for any projection of the planet upon the moon's edge, but could see none.

"It is perhaps worth mentioning, that the planet's second limb, during, and for several seconds after its final emersion, and in both states of the adjustment of the telescope, appeared to have a very considerable curvature towards the moon's dark limb. The planet, however, soon returned to a shape nearly spheroidal."

3. By Captain Smyth, containing the same observations. Captain Smyth also remarks:

"Although the emersions of the satellites were perfectly distinct, they were certainly not so instantaneous as those of the small stars; which I think was more owing to light than disc. Jupiter entered into contact rather sluggishly; but though the lunar limb was tremulous from haze, there was not the slightest loss of light. Faint scintillating rays preceded the emersion, which was so gradual, that, as the planet re-appeared, the edge of the moon covered it with a perfectly *even* and black segment, which cut the belts distinctly, and formed clear sharp cusps, slowly altering until the

whole body was clear. There was no appearance of raggedness from lunar mountains, and Jupiter's belts were superbly plain while emerging; but there was not the slightest distortion of figure, diminution of light, or change of colour."

In allusion to the deviation seen by Messrs. Ross and Comfield, which is inserted in the Memoirs, Captain Smyth mentions the following fact:

"On Thursday the 26th of June, 1828, the moon being nearly full, and the evening extremely fine, I was watching the second satellite of Jupiter as it gradually approached to transit its disc. My instrument was an excellent refractor, of $3\frac{3}{4}$ inches aperture, and 5 feet focal length, with a power of 100. It appeared in contact at about half-past 10, by inference, and for some minutes remained on the edge of the limb, presenting an appearance not unlike that of the lunar mountains coming into view during the first quarter of the moon, until it finally disappeared on the body of the planet. At least twelve or thirteen minutes must have elapsed, when, accidentally turning to Jupiter again, to my astonishment I perceived the same satellite *outside the disc!* It was in the same position as to being in a line with the apparent lower belt, where it remained distinctly visible for at least four minutes, and then suddenly vanished."

The same phenomenon was also observed on the same evening, at different places, by Mr. Maclear and Dr. Pearson.

II. A letter from Mr. Dawes to Mr. Herschel, giving observations of the double stars, 70 Ophiuchi, ξ Ursæ Majoris, 44 Bootis, γ Virginis, η and σ Coronæ, Castor, γ Leonis, and ε Bootis, made during the last and present year. Mr. Dawes is of opinion that the apparent discs are more affected by the aperture of the telescope than by any other circumstance; and that this is the principal reason why a reflector presents a smaller image of a fixed star than an achromatic of equal illuminating power.

III. The reading of Mr. Herschel's paper on the measures of 364 double stars was completed.

This paper contains the micrometrical measures of the angles of position and distances of 364 double stars, observed by Mr. Herschel with the seven-feet equatorial in his possession at Slough, the same which was used by Sir James South in his observations at Passy, and in a part of the measures of double stars in the *Philosophical Transactions* for 1824. The individual measures, being too numerous, are not stated; but the mean results of each night's observation are set down in tabular order, with a weight attributed to each, indicative of the degree of confidence which the observer himself attributes to them, and with notes attached, descriptive of any peculiar circumstances in the observation proper to be recorded. They comprise the results of 735 sets of measures, or from 6000 to 8000 individual observations, obtained under all atmospheric circumstances, in the years 1828, 1829, and 1830. Almost all the stars observed are taken from the great catalogue of Struve.

The author prefaces his observations by a comparison of his results with those already obtained by other observers in the cases where his stars *have* been observed by others, and draws a conclusion not unfavourable to the general accuracy of his angles of position; although, in some individual cases, considerable discrepancies and even grievous errors are admitted. In the course of this comparison he is led to point out some stars as having so materially changed, at least apparently, that he is induced to recommend them for further observation, as being possibly of a binary nature. With regard to his distances, he professes himself much dissatisfied, owing to an imperfection in the micrometer attached to the instrument, which is the same with that used in all its former measurements, and of which the cause has been detected too late to remedy the evil.

After noticing some peculiarities in his mode of observation, and in particular his use of a red illumination of the wires, which he regards as a great improvement, he enters into a more particular examination of the bearing of his present results on the theory and history of the following stars, whose motions he considers as fully demonstrated by them, although some of them had previously been brought into question.

η Cassiopeæ.	γ Virginis.	39 Draconis.
η Persei.	η Coronæ.	ε^1 Lyræ.
Castor.	μ^2 Bootis.	ε^2 Lyræ.
ζ Cancri.	49 Serpentis.	ζ Sagittæ.
ω Leonis.	σ Coronæ.	61 Cygni.
γ Leonis.	μ Draconis.	δ Equulei.
ξ Ursæ.	70 Ophiuchi.	ζ Aquarii.

Among these the most remarkable of his conclusions refer to Castor, ζ Cancri, ξ Ursæ, γ Virginis, and η Coronæ. In the cases of Castor and γ Virginis, he is enabled, by the kindness of Professor Rigaud, to produce observations of their positions by Bradley and Pound, which are peculiarly valuable, as they carry back the history of these stars upwards of a century, and enable us to form a much better judgment than heretofore of their orbits, both which appear to be ellipses of considerable elongation. He describes a very ready and easy graphical process by which these orbits may be approximately laid down, and exemplifies it on γ Virginis, respecting which he concludes that the present approach of the stars, and increase of their angular velocity, will still go on for several years, until their distance is reduced to less than a single second, which, considering the brightness of both individuals, will render this a single star to all but the very finest telescopes. Castor he also considers likely, ere very many years have elapsed, to become a close double star, and again to open to a much more considerable distance than at present.

In the case of ζ Cancri, he is led by his observations to conclude that the motion is retrograde instead of direct, and much more

rapid, so that this star has nearly completed a whole revolution. This conclusion is fully confirmed by his observations of the present spring (1831), and also by the observations of Mr. Dawes, which have been communicated to him very recently, and which agree in a very remarkable manner with his own, and actually suffice to trace the bimestral motion of the star, as had been previously done in the case of ξ Ursæ. η Coronæ, too, offers, if all the observations can be trusted, a still more remarkable instance of quick rotation, being already considerably advanced in its *second* revolution since Sir Wm. Herschel's first discovery of it; but this will require further confirmation, owing to the extreme difficulty of the measures. The periods of these two stars may be stated respectively at 55 and 43 years; that of ξ Ursæ at $56\frac{1}{2}$, which last determination agrees nearly with that of M. Savary, who has assigned $58\frac{1}{2}$ years for this element. The period of 70 Ophiuchi has been determined by Professor Encke at 73·862 years.

Lastly, Mr. Herschel subjoins some practical remarks on the management and action of telescopes, and takes occasion to introduce a set of measures of the positions of Saturn's satellites, taken under remarkably favourable circumstances, and also a single observation of the place of the comet of 1830, the only one he could succeed in procuring.

In a subsequent letter received from Mr. Herschel, he alludes to a new method of taking the angles of position, viz., by reflected as well as by direct vision. He conceives that this method possesses two capital advantages: 1st, That the quantity directly measured is double the quantity sought, by which, of course, the error of determination is halved; and, 2dly, That the error of the zero is destroyed altogether, the double arc being given by the difference of readings in the limb of one and the same circle, maintained in one and the same position. Mr. Herschel also adds, that subsequent and very satisfactory measures of η Coronæ fully confirm the conclusion above mentioned with regard to the revolution of that star.

IV. On the dependence of a clock's rate on the height of the barometer, by the Rev. Dr. Robinson.

The rate of a clock of good workmanship may be assumed to depend on three things; first, the rate at a given temperature and barometric pressure: secondly, on the variation of temperature, as shewn by the thermometer; and thirdly, upon the atmospheric pressure, measured by the barometer. The variation of temperature not only affects the materials of the pendulum, but, along with the atmospheric pressure, greatly modifies the action of the air in the way of *buoyancy* and *inertia*, &c. Possibly, the irregular action of the wheelwork, the diminution of arc from the thickening of the oil on the pallets, and even the hygrometric state of the air, may sensibly alter the rate of a clock; but the present memoir is confined to the consideration of the first-mentioned sources of error.

As the changes are minute, Dr. Robinson formed equations of condition, where the quantities sought were the rate of the clock at

49° of the thermometer, and 29·5 inches of the barometer, and the retardations corresponding to a rise of 1° and 1 inch in each of these instruments respectively. The absolute gain or loss of the clock was determined with the utmost care.

" A thermometer placed in the clock-case, with its bulb three inches before the pendulum rod, and on a level with the cover of the jar, and a barometer with its cistern at the same level, were noted morning and evening at half-past nine; a time chosen, not merely as likely to give mean results for the whole day, but also because it nearly bisects the average period of evening observations. The thermometer was read through a square of plate glass, cemented in the door of the case; and this being screwed close, (as described in the *Armagh Observations* for 1828,) all free communication with the air is precluded, and the changes of temperature within it are slower and more regular than would be possible in clocks of the ordinary construction. This made observations at other than the stated periods unnecessary. The barometer was observed whenever its movements seemed irregular, and the mean for the day corrected, if necessary, by interpolation."

Dr. Robinson then shews that the equations, when treated by the method of least squares, give, for the gaining rate of the clock at the standard temperature and pressure, $0^s,263$; for the gain by an increase of 1° in the temperature (his clock was over compensated), $0^s,069$; and for the gain by a depression of 1 inch in the barometer, $0^s,241$. As the mere effect of the air's buoyancy on the mercurial pendulum is $0^s,15$ for a change of 1 inch in the barometer, the remainder is due to the inertia of the air carried along with the pendulum in its oscillations.

Dr. Robinson finds that the barometrical pressure has no sensible effect upon the *arc of vibration*, and, consequently, does not affect the clock through this cause.

With respect to the barometric variation of rate, having once determined its co-efficient, nothing is easier than to allow for it when any sudden change occurs: it may, however, be corrected mechanically with the utmost facility. A rise in the barometer tends to make a clock go slower. Suppose a syphon barometer to be attached to the pendulum, then a rise in the barometer will transfer a portion of the mercury in the syphon to the tube, and the effect will be the same as if a small weight were shifted from the syphon end to the tube end of the barometer. Now if the syphon be so adjusted to the pendulum, as to bore and situation, that this alteration of the mercury in the barometer will accelerate the rate as much as the increase of the air's buoyancy and inertia retard it, the clock will be unaffected by any variation of the atmospheric pressure.

Dr. Robinson shews how the syphon barometers (he places two, one on each side of the pendulum rod) may be constructed and adjusted for any particular case.

" I had previously recognised the influence of the barometer on the clock before the mercurial pendulum was applied; and, without

employing the method of minimum squares, satisfied myself that the effect was even greater, being nearly 0·3 for an inch. In examining this point for any given clock, it is however to be remembered, that it is always necessary to make the probable errors of observation considerably less than the quantity sought; otherwise, no conclusive result can be obtained. This may be done, either by taking the rate for intervals of several days, or by observing several stars on each night."

A List of Stars observed with the Moon, in the present year, at the Royal Observatory, Greenwich.

1831.		h. m. s.	1831.		h. m. s.
Jan. 6.	Spica Virg.	13 17 6,08	Feb. 26.	48 Leonis	10 26 25,46
	☽ 2 L	14 2 43,42		o^1 Sextantis	10 37 44,26
7.	Spica Virg.	13 17 6,94		o^2 ——	10 38 58,17
	☽ 2 L	14 50 2,08		☽ 2 L	10 54 24,16
24.	111 Tauri	5 15 34,20	Mar. 23.	☽ 1 L	8 45 15,92
	☽ 1 L	5 24 33,76		π^2 Cancri	9 6 40,57
	N Tauri	5 38 35,46	27.	(50) Leonis	11 15 29,88
	χ^4 ——	5 54 27,40		(77) ——	11 20 6,86
25.	☽ 1 L	6 27 32,76		υ ——	11 29 8,96
	G Geminor.	6 41 7,24		☽ 1 L	12 13 22,98
	(281) ——	6 48 53,34	April 20.	☽ 1 L	9 24 42,42
	ξ ——	6 55 6,04		♆ Leonis	9 35 40,74
26.	☽ 1 L	7 30 6,74	May 22.	☽ 1 L	13 18 27,40
	g Geminor.	7 37 22,62		l^3 Virginis	13 28 2,80
Feb. 5.	1 β Scorpii	15 56 46,70		(174) ——	13 36 25,84
	☽ 2 L	15 8 6,62	24.	λ Virginis	14 11 17,78
	Antares	16 20 12,40		(127) Libræ	14 29 20,18
19.	☽ 1 L	4 4 11,04		μ ——	14 41 23,18
	h^3 Tauri	4 13 51,36		☽ 1 L	14 53 6,26
	π ——	4 18 22,86	25.	ξ^3 Libræ	15 22 29,04
	ϱ ——	4 25 34,94		γ ——	15 27 24,72
				☽ 1 L	15 41 37,50

N.B. The Astronomer Royal having kindly offered to furnish the Society, from time to time, with the observations of moon-culminating stars, made at Greenwich, the first series is here given for the present year; and they will be continued in the subsequent Monthly Notices, as they are received; by which means they will become more speedily accessible to those persons who are desirous of making comparisons of this kind.

J. Moyes, 28, Castle Street, Leicester Square.